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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2019

**Centre Number**

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**Candidate Number**

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# Chemistry

Assessment Unit AS 1

*assessing*

Basic Concepts in Physical  
and Inorganic Chemistry

<b>MV18</b>
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**[SCH12]**

**MONDAY 20 MAY, MORNING**

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## Time

1 hour 30 minutes, plus your additional time allowance.

## Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all sixteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all six** questions in **Section B**. **You must answer the questions in the spaces provided.**

**Do not write on blank pages.**

Complete in black ink only.

## Information for Candidates

The total mark for this paper is 90.

Quality of written communication will be assessed in

Question **15(c)**.

In Section A all questions carry equal marks, i.e. **one** mark for each question.

In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

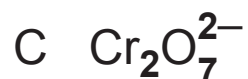
A Periodic Table of Elements, containing some data, is included with this question paper.

## Section A – Multiple Choice

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

Each multiple choice question is worth 1 mark.

1 In which of the following does chromium **not** have an oxidation state of +6?



2 Which bonding type is described as intermolecular?

A Covalent

B Ionic

C Metallic

D van der Waals' forces

3 Which of the following is the formula of the nitrite ion?



4  $25.0\text{ cm}^3$  of 0.10 M sodium hydroxide solution is exactly neutralised by

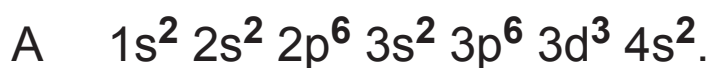
A  $12.5\text{ cm}^3$  of 0.05 M sulfuric acid.

B  $25.0\text{ cm}^3$  of 0.05 M sulfuric acid.

C  $12.5\text{ cm}^3$  of 0.20 M sulfuric acid.

D  $25.0\text{ cm}^3$  of 0.10 M sulfuric acid.

5 The electronic configuration of a Group III element is



6 The bond angle in ammonia is

A 104.5°.

B 107°.

C 109.5°.

D 120°.

7 The sulfate(VI) ion can be reduced to sulfur dioxide.



Which of the following represents the correct values of x, y and z?

	x	y	z
A	2	2	4
B	2	4	2
C	4	2	2
D	4	4	2

- 8 Which type of titration can use phenolphthalein as a suitable indicator?
- A Strong acid/strong base only
  - B Strong acid/strong base and weak acid/strong base
  - C Strong acid/strong base and strong acid/weak base
  - D Strong acid/weak base and weak acid/strong base
- 9 In which of the following molecules does the central atom obey the octet rule?
- A  $\text{BF}_3$
  - B  $\text{BeCl}_2$
  - C  $\text{ClF}_3$
  - D  $\text{PH}_3$
- 10 Which species is the most powerful oxidising agent?
- A Bromide
  - B Bromine
  - C Chloride
  - D Chlorine

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**(Questions continue overleaf)**

## Section B

Answer **all six** questions in the spaces provided.

**11** Water can act as an acid or as a base. It can either lose or gain hydrogen ions.

**(a)** State and explain the shape of a water molecule.  
[3 marks]

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**(b)** Water can react with hydrogen ions forming hydroxonium ions,  $\text{H}_3\text{O}^+$ .

**(i)** Draw a dot and cross diagram to show the bonding in a hydroxonium ion, showing all the outer shell electrons. [2 marks]



- (ii) Suggest why the bond angle in the hydroxonium ion is greater than the bond angle in water. [2 marks]

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- (iii) Suggest why the hydroxonium ion does not react with a hydrogen ion to form  $\text{H}_4\text{O}^{2+}$ . [1 mark]

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- 12** Four new elements have recently been added to the Periodic Table. The four elements are given below, along with their atomic numbers and the mass numbers of their most common isotope.

element	atomic number	mass number
nihonium	113	286
moscovium	115	289
tennessine	117	294
oganesson	118	294

**(a)** What is the meaning of the following terms?

**(i)** Atomic number [1 mark]

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**(ii)** Mass number [1 mark]

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**(iii)** Isotopes [1 mark]

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**(b)** State and explain which element has the most neutrons.  
[2 marks]

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- (c) Suggest why tennessine is placed in Group VII of the Periodic Table. [1 mark]
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- (d) Erbium is a soft, silvery solid that tarnishes slowly in air. It is used in fibre optic cables. There are six known isotopes of erbium and its relative atomic mass is 167.26.

- (i) Define the term **relative isotopic mass**. [2 marks]
- 
- 

- (ii) The table below gives the percentage abundances of six isotopes in the mass spectrum of erbium.

<b>relative isotopic mass</b>	161.93	163.93	165.93		167.93	169.94
<b>% abundance</b>	0.14	1.60	33.50	22.87	26.98	14.91

Calculate the missing relative isotopic mass.  
[3 marks]

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**13** Chloroauric acid,  $\text{HAuCl}_4$ , is an orange solid that is used widely in gold refining. During World War II, the Hungarian chemist George de Hevesy dissolved two gold Nobel Prize medals in a mixture of concentrated nitric and hydrochloric acids to prevent the Germans from confiscating them. Later the medals were reconstructed from the dissolved chloroauric acid and returned.

- (a)** The reaction between gold, concentrated hydrochloric acid and concentrated nitric acid produces chloroauric acid, nitrogen(IV) oxide and water. Write the equation for this reaction. [2 marks]
- 

- (b)** Gold is extracted from recycled electronic materials by reaction with chlorine and hydrochloric acid, forming chloroauric acid. Elemental gold is recovered by electrolysis of chloroauric acid.



- (i)** Deduce the oxidation state of gold in chloroauric acid. [1 mark]
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- (ii)** With reference to oxidation numbers, explain why this is a redox reaction. [3 marks]
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**(c)** When heated, chloroauric acid forms gold(III) chloride and hydrogen chloride gas. The bonding in gold(III) chloride is considered to be covalent.

**(i)** Suggest, in terms of electronegativity, why the bonding in gold(III) chloride is covalent. [1 mark]

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**(ii)** Describe the chemical test for hydrogen chloride gas. [2 marks]

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**14** The recommended daily allowance for salt, sodium chloride, is 6.0 g. Eating too much salt can lead to high blood pressure, potentially causing heart disease and strokes.

**(a)** State the electronic configuration of a sodium atom and use it to explain why sodium is regarded as an s-block element. [2 marks]

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**(b) (i)** Define the term **Avogadro's constant**. [1 mark]

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**(ii)** Calculate the number of sodium ions in the recommended daily allowance of sodium chloride. [2 marks]

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**(c)** A solid sample of salt was analysed to confirm the identity of the ions present.

A flame test was first conducted on the sample using nichrome wire and concentrated hydrochloric acid to identify sodium ions. The presence of chloride ions was subsequently confirmed.

**(i)** State **two** reasons why **nichrome** wire was used. [2 marks]

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(ii) State **two** reasons why concentrated hydrochloric acid was used. [2 marks]

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(iii) State the colour observed in the flame test. [1 mark]

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(d) Describe how the presence of chloride ions could be confirmed in the solid salt. [4 marks]

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(e) A second salt sample was thought to be contaminated with sodium carbonate. Describe a chemical test to confirm the presence of carbonate ions. [3 marks]

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- (f) The salt sample, of mass 6.0 g, contaminated with sodium carbonate was dissolved in water. A solution of magnesium chloride was added, forming a precipitate of magnesium carbonate. The precipitate was filtered off and dried to give 1.4 g of magnesium carbonate.
- (i) Draw a dot and cross diagram to show the bonding in magnesium chloride showing all the outer electrons. [2 marks]
- (ii) Write the equation for the reaction between sodium carbonate and magnesium chloride. [2 marks]
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- (iii) Use the following headings to calculate the percentage of sodium carbonate in the salt sample.  
[6 marks]

Relative formula mass of magnesium carbonate

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Number of moles of magnesium carbonate

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Number of moles of sodium carbonate

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Relative formula mass of sodium carbonate

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Mass of sodium carbonate in the sample

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Percentage of sodium carbonate in the sample

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**15** The third Period in the Periodic Table from sodium to argon displays a number of periodic trends.

**(a)** State and explain the general trend in first ionisation energy across Period three. [3 marks]

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**(b) (i)** Write an equation, including state symbols, for the first ionisation energy of phosphorus. [2 marks]

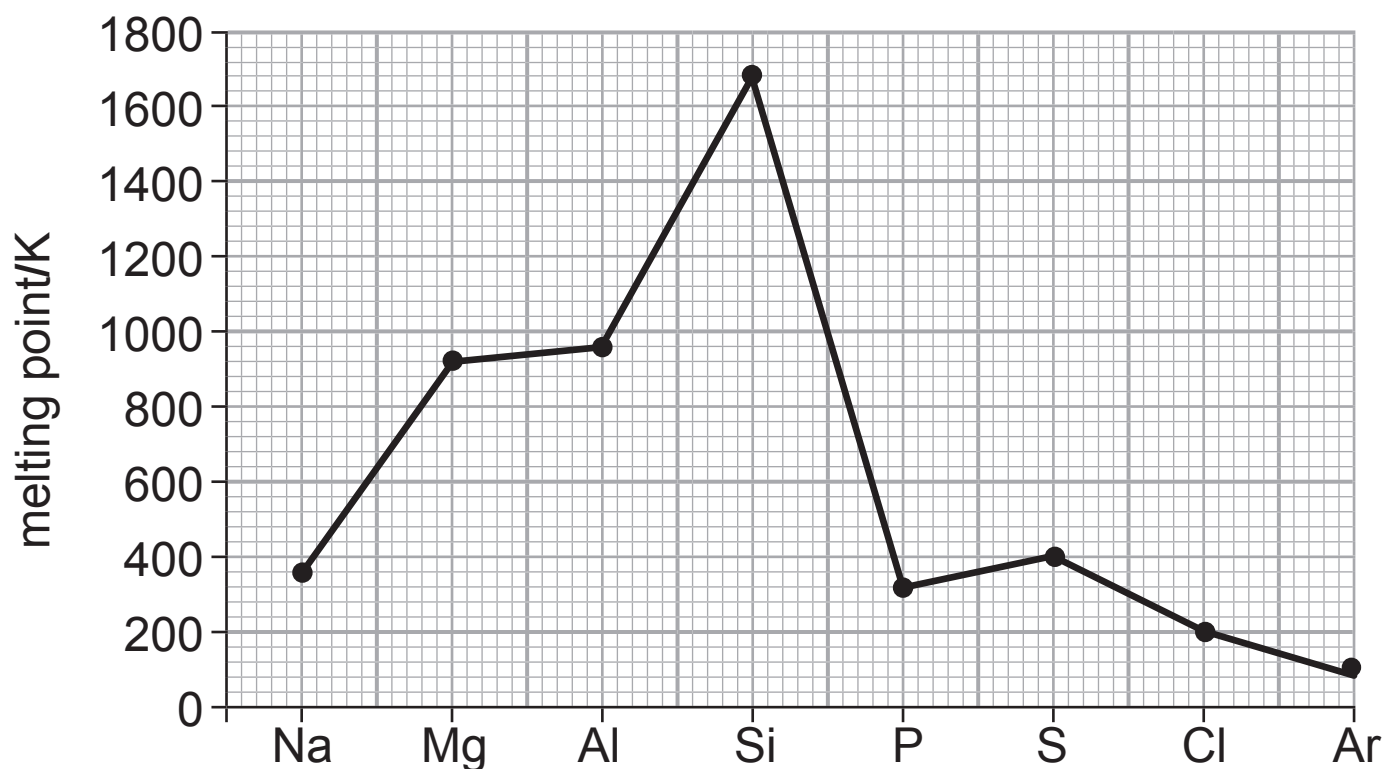
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**(ii)** Explain why the first ionisation energy of phosphorus is higher than that of sulfur. [2 marks]

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(c) The graph below shows the melting points of the elements in the third Period.



With reference to the structure and bonding of the elements, explain the change in melting point from **silicon** to **argon**. [6 marks]

**In this question you will be assessed on your written communication skills including the use of specialist scientific terms.**

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**16** Lead(II) iodide is yellow and was once used as a pigment in paint until concerns over its toxicity led to its use being discontinued. It has a low solubility in water.

**(a)** Lead(II) iodide can be prepared by reaction between solutions of potassium iodide and lead(II) nitrate. Write the equation for this reaction. [2 marks]

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**(b)** 75.6 mg of lead(II) iodide dissolve in 100 cm<sup>3</sup> of water at 20°C. Calculate the molarity of iodide ions in a saturated solution of lead(II) iodide at 20°C. [4 marks]

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**(c)** Chlorine water was added to potassium iodide solution in a test tube.

**(i)** State the colour observed. [1 mark]

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**(ii)** A solution of starch was then added to the test tube. State the colour observed. [1 mark]

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- (d) (i) State **three** observations made when concentrated sulfuric acid is added to solid potassium iodide.  
[3 marks]

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- (ii) Explain why concentrated phosphoric acid does not give iodine when added to solid potassium iodide.  
[1 mark]

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**THIS IS THE END OF THE QUESTION PAPER**

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## General Information

1 tonne =  $10^6$  g

1 metre =  $10^9$  nm

One mole of any gas at 293 K and a pressure of 1 atmosphere ( $10^5$  Pa) occupies a volume of 24 dm<sup>3</sup>

Avogadro Constant =  $6.02 \times 10^{23}$  mol<sup>-1</sup>

Planck Constant =  $6.63 \times 10^{-34}$  Js

Specific Heat Capacity of water =  $4.2 \text{ J g}^{-1} \text{ K}^{-1}$

Speed of Light =  $3 \times 10^8 \text{ m s}^{-1}$

## Characteristic absorptions in IR spectroscopy

Wavenumber/cm <sup>-1</sup>	Bond	Compound
550–850	C–X (X = Cl, Br, I)	Haloalkanes
750–1100	C–C	Alkanes, alkyl groups
1000–1300	C–O	Alcohols, esters, carboxylic acids
1450–1650	C=C	Arenes
1600–1700	C=C	Alkenes
1650–1800	C=O	Carboxylic acids, esters, aldehydes, ketones, amides, acyl chlorides
2200–2300	C≡N	Nitriles
2500–3200	O–H	Carboxylic acids
2750–2850	C–H	Aldehydes
2850–3000	C–H	Alkanes, alkyl groups, alkenes, arenes
3200–3600	O–H	Alcohols
3300–3500	N–H	Amines, amides

## Proton Chemical Shifts in Nuclear Magnetic Resonance Spectroscopy (relative to TMS)

Chemical Shift	Structure	
0.5–2.0	–CH	Saturated alkanes
0.5–5.5	–OH	Alcohols
1.0–3.0	–NH	Amines
2.0–3.0	–CO–CH	Ketones
	–N–CH	Amines
	C <sub>6</sub> H <sub>5</sub> –CH	Arene (aliphatic on ring)
2.0–4.0	X–CH	X = Cl or Br (3.0–4.0) X = I (2.0–3.0)
4.5–6.0	–C=CH	Alkenes
5.5–8.5	RCONH	Amides
6.0–8.0	–C <sub>6</sub> H <sub>5</sub>	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
10.0–12.0	–COOH	Carboxylic acids

These chemical shifts are concentration and temperature dependent and may be outside the ranges indicated above.

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New  
Specification



# Data Leaflet

## Including the Periodic Table of the Elements

For the use of candidates taking  
Advanced Subsidiary and  
Advanced Level Examinations

**Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations**

# gce a/as examinations chemistry

For first teaching from September 2016  
For first award of AS Level in Summer 2017  
For first award of A Level in Summer 2018  
Subject Code: 1110

IIIIVVVIVII0

THE PERIODIC TABLE OF ELEMENTS

Group

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 <b>H</b> Hydrogen 1																	4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12											27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganes 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	98 <b>Tc</b> Technetium 43	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> <sup>*</sup> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86
223 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> <sup>†</sup> Actinium 89	261 <b>Rf</b> Rutherfordium 104	262 <b>Db</b> Dubnium 105	266 <b>Sg</b> Seaborgium 106	264 <b>Bh</b> Bohrium 107	277 <b>Hs</b> Hassium 108	268 <b>Mt</b> Meitnerium 109	271 <b>Ds</b> Darmstadtium 110	272 <b>Rg</b> Roentgenium 111	285 <b>Cn</b> Copernicium 112						

\* 58 – 71 Lanthanum series  
† 90 – 103 Actinium series

aXb

a = relative atomic mass (approx)  
x = atomic symbol  
b = atomic number

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	145 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	242 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	245 <b>Bk</b> Berkelium 97	251 <b>Cf</b> Californium 98	254 <b>Es</b> Einsteinium 99	253 <b>Fm</b> Fermium 100	256 <b>Md</b> Mendelevium 101	254 <b>No</b> Nobelium 102	257 <b>Lr</b> Lawrencium 103